Acronym: SpaceDRUMS

Title: Space-Dynamically Responding Ultrasonic Matrix System

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Sponsoring Agency: National Aeronautics and Space Administration (NASA)

Increment(s) Assigned: 19, 20

Brief Research Summary (PAO): Space-Dynamically Responding Ultrasonic Matrix System (SpaceDRUMS) comprises a suite of hardware that enables containerless processing (samples of experimental materials can be processed without ever touching a container wall). Using a collection of 20 acoustic beam emitters, SpaceDRUMS can completely suspend a baseball-sized solid or liquid sample during combustion or heat-based synthesis. Because the samples never contact the container walls, materials can be produced in microgravity with an unparalleled quality of shape and composition. The ultimate goal of the SpaceDRUMS hardware is to assist with the development of advanced materials of a commercial quantity and quality, using the space-based experiments to guide development of manufacturing processes on Earth.

Research Summary:

- The goal of SpaceDRUMS is to provide a suite of hardware capable of facilitating containerless advanced materials science, including combustion synthesis and fluid physics. That is, inside SpaceDRUMS samples of experimental materials can be processed without ever touching a container wall.

- The initial use of the SpaceDRUMS payload is designed to conduct a series of combustion synthesis experiments, during which marble-sized pellets of material will be processed to create new materials with unique structures and properties.

- The ultimate goal of the SpaceDRUMS hardware is to assist with the development of advanced materials of a commercial quantity and quality best achievable in space, initially using space to teach us how to make these exotic materials on earth.

- Samples of simulated lunar soil will also be processed that may be useful in designing future shielding materials on the moon.

Detailed Research Description: The SpaceDRUMS hardware requires a full EXPRESS rack for deployment and it's components are housed in several Middeck Locker equivalent EXPRESS rack inserts. The center of the hardware is the Sputnik-resembling, spherical sample processing chamber. There is

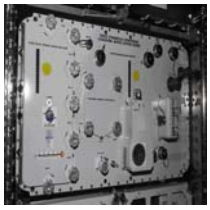
also a sample storage compartment that can store up to five samples before and after processing. The samples are stored in a rotating carousel that can autonomously deliver samples, one after another, to be processed. Sample carousels can be manually replaced and stowed by the ISS crew. The primary processing unit of SpaceDRUMS is a quad locker EXPRESS rack insert, which four other single locker inserts contain the various electronics, computer processors, acoustic processors, and Argon gas system (used to help create a vacuum in the sample chamber).

SpaceDRUMS will facilitate research and materials processing in a manner that can only be accomplished in the microgravity environment aboard the ISS. The benefits of SpaceDRUMS will include not only further scientific understanding of processes like conbustion synthesis and self-propagating high temperature synthesis, but also direct commercial benefits from materials processing. Advanced ceramics, polymer, and colloids can be processed in SpaceDRUMS.

Project Type: Commercial Payload

Images and Captions:


SpaceDRUMS hardware loaded into an ExPRESS Transportation Rack (ETR).


SpaceDRUMS Processing Module.


SpaceDRUMS Processing Chamber.


The dodecahedron combustion chamber shown above is the central part of the Processing Module. It has 20 acoustic transducers attached on the corners and three cameras for providing sample position feedback and for viewing and recording the action. The Processing Module is the quad-locker portion of SpaceDRUMS.

Operations Location: ISS Inflight

Brief Research Operations:

- The crew will load cartridges with the pellets into the SpaceDRUMS processing modules.
- Ground commands will then be sent to process the samples, following the completion of sample processing, another set of commands will be sent to end sample processing.
- SpaceDRUMS will require routine maintenance operation by the crew.

Operational Requirements: Crew time is required for the initial installation and set-up of SpaceDRUMS as well as each time the hardware is activated. However, once the ISS crew turns on the power, and loads pellet carousels and debris traps, the ground commanding is all that is required to operate the experiment. Throughout the course of the payloads stay on the ISS, crew time may also be required for cleaning the chamber. Despite some crew time, though, SpaceDRUMS is a largely autonomous payload.

Operational Protocols: SpaceDRUMS is a largely autonomous piece of hardware. Samples for SpaceDRUMS are contained in a rotating five-chamber carousel. Once the SpaceDRUMS facility is switched on the by the crew and carousel inserted, ground teams can command the introduction of a sample from the carousel into the SpaceDRUMS processing chamber. Before a sample is introduced to the processing chamber, however, argon is used to purge the chamber to ensure no particulate matter interferes with the experiment. Argon is also used as the sound medium and being inert does not react with the sample. Vacuum is used to clear the chamber between experiments. Any small particles removed during the vacuum draw are contained in the SpaceDRUMS debris trap. All the processing activities are completely self-contained and automated. Once the sample has been processed it is returned to the sample carousel and a new sample can be introduced to the processing chamber. Crew time is required to replace old carousels with new ones containing unprocessed samples. Crew time may also be required the replace debris traps, filters that eliminate particulate matter from the processing chamber.

Review Cycle Status: PI Reviewed

Category: Technology Development

Sub-Category: Spacecraft Materials

Space Applications: Any new materials developed using the SpaceDRUMS technology may have significant applications in space as well as on Earth. Some of the advanced ceramics, lighter and more durable, may have applications in new spacecraft or extraterrestrial outposts, such as bases on the Moon. Advances in fluid physics stemming from SpaceDRUMS may also have applications in future spacecraft propulsion systems.

Earth Applications: An already demonstrated capability of the combustion synthesis facilitated by SpaceDRUMS is the production of advanced porous and glass ceramics for which patents have been awarded. New innovations from this hardware can include a very light and strong new class of porous glass ceramic material, exhibiting high temperature tolerance, controlled porosity, functionally graded and acoustic absorption, and high wear resistance. These materials are ideal for a wide range of potential applications, from dental and bone replacement, noise reduction in engines, filters, cutting tools and drill bits.

Manifest Status: New

Supporting Organization: Exploration Systems Mission Directorate (ESMD)

Previous Missions: SpaceDRUMS prototypes have flown on the KC-135 program.

Related Publications:
Hart DA, Rowsell G, SPACE-DRUMS - Challenges Involved in Quad Locker Integration AIAA 2001

Web Sites:
Guigne

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